SCIENCE

NEW SERIES
VOL. LIX, No. 1516

FRIDAY, JANUARY 18, 1924

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

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VOL. LIX JANUARY 18, 1924 No. 1516

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

SOME ASPECTS OF MODERN SPECTROSCOPY[1]

SEVENTEEN years ago, at the meeting in New York, some of us had the pleasure of listening to an address entitled "Fact and theory in spectroscopy," given to this section by its retiring chairman, Professor Henry Crew. It included a comprehensive and enlightening survey of atomic theory and of the requirements imposed upon any successful atomic model by the facts of spectroscopy known at that time. In the light of more recent work on this subject, it may be interesting to look at this same field, and consider in part the contributions of spectroscopy to atomic theory in this interval.

Your first reaction to such a proposal is perhaps a very natural fear that the territory to be covered is so vast that you must suffer an exhausting experience in being dragged over the whole of it, or be whisked about from point to point at a speed that will not allow you to enjoy the comforts of leisurely travel. Let me say at once that we shall view but a small corner of this domain, and, since I am to choose the route, it shall be from a standpoint with which until quite recently comparatively few were acquainted, but which nowadays is starred in the atomic Baedeker, and has suddenly achieved an enormous popularity.

It is with a certain sense of satisfaction that the experimental spectroscopists may legitimately regard their labors in the recent past. Twenty-five years ago there were those who said that the spectra of all the elements had been "done" by Kayser and Runge, and that there remained in this field nothing more attractive to seek than the next decimal place in wavelengths. In spite of such pessimism, important advances began to be made, of which a few might be mentioned at this point. These years brought us the best part of the work of that gifted and brave spirit, Walter Ritz, whose early death was a very real loss to science. He gave us his famous combination principle, which first demonstrated the importance of spectroscopic "terms," now translated into energies by the Bohr theory. Then came a steady growth in our knowledge of the series structure in the simpler spectra, including the interpretation of the "spark" spectrum as that due to the ionized atom, and the

[1] Address of the vice-president and chairman of Section B—Physics—American Association for the Advancement of Science, Cincinnati, Ohio.

discovery by Fowler that this was also a series spectrum. A masterly series of researches by Paschen disclosed the extent and importance of the infra-red region, and (with Runge and Back) laid down a foundation of fact in regard to the Zeeman effect. Perhaps the most remarkable single piece of work in practical spectroscopy was Paschen's astonishing analysis of the spectrum of *Ne*, showing that in all probability all spectra were series spectra, though complex, and indicating the path forward in this tangled field. A steady improvement in technique and the invention of new sources of light have brought us to our present much improved situation. Nevertheless, it would now be quite reasonable to say that we are even yet at the verge of an untrodden field, with many of the most important facts in regard to the spectra of the elements still unknown.

The study of spectra possesses an unmistakable charm. We renew annually through our students that thrill that once came to each of us when we saw for the first time the spectrum of a luminous gas. What an enticing puzzle it presented! Here in the study of these vibrations was a chance to view the actions of an atom itself, to catch it in the very act of the performance of its most secret rites. Surely, we used to say, from the study of these vibrations we may attack the problem of atomic structure on purely mechanical principles, just as a blind listener might seek to deduce the fundamental structure of a musical instrument from the tones which it emitted. It was no simple problem, for there were many atoms whose known gamut of vibrations would put a complete orchestra to shame in its variety, if not in its range. Professor Crew left us after his address with a feeling that this problem was far from its solution. One great principle, which was then accepted by all, is stated by him:—"The hypothetical radiant atom must not in its behavior, except as a very last resort, contradict any of the established principles of physical science, be they mechanical, electrical or chemical." It was impossible to see how any of the models then proposed could be satisfactory on this basis.

There are always among us conservatives and radicals. The former, with a wide vision over the past, continually remind us of the difficulties into which we shall fall if we abandon those principles that have already been shown to be useful. The latter are acutely sensitive to the dilemmas furnished by the present, and are willing to rush in where the conservatives fear to tread, and adopt any new hypotheses that appear likely to bring us a step forward. No moving machine is complete without motor and brakes; the motor calls for motion at all costs, the brakes for caution, or even complete stagnation. It is illegal to drive without brakes, but impossible to progress without a motor. Let us not therefore waste time trying to assign praise or blame to the conservatives or to the liberals in this matter. The fact is that, as far as progress in atomic theory went, our machine appeared to be stalled with the brakes jammed, until it occurred to Bohr, perhaps "as a very last resort," to postulate that there were processes going on in a radiating atom for which we have no mechanical models.

According to his theory, as you all know, we must assume a series of stationary states in the atom differing from one another in their energy content, and such that when the atom changes from one to another, a quantity of energy is liberated in the form of monochromatic radiation, whose frequency is proportional to the change of energy involved. It is to be noted that this theory gives us no definite idea of how the energy is emitted, how it happens to take the form of monochromatic radiation, apparently with all the properties of wave-motion, why its frequency follows the curious quantum law; nor have we as yet a definite idea of what the circumstances are which cause the atom to change from one stationary state to another. These and other features of the picture are left blank, to be filled in later on.

There are those who say that man is too finite an animal ever to be able to comprehend all the mysteries of nature. Perhaps in atomic theory we ought to postulate some fundamental thing or state of affairs and agree not to attempt to conceive of what lies beyond. Most of us will, I think, object to this abandonment of the chase so long as there are complexities unsolved. We demand ultimate simplicity on the part of nature. Theories which are complex and elaborate are not likely to be long-lived and fruitful. The charm of the Bohr theory is the simplicity which it has introduced into spectroscopy; but so long as the picture it gives us of the atom is complex and full of apparent miracles, the search for simpler conceptions will surely continue. Open processes, openly arrived at, are as desirable here as in politics, and perhaps as unlikely to be attained.

Bohr has shown it to be profitable to regard the stationary states as planetary orbits in which the electron revolves, at least in the case of the simplest atoms, according to mechanical laws, and the change from one of these states to another requires the electron to leave one orbit and fall into some other in a manner that would be most unbecoming of a member of a solar system. Perhaps it would be better to describe the process as one of complete disappearance in one orbit, and reappearance in the new one, for there is no clew as to the whereabouts or the actions of the electron during the change.

I need not here recount the brilliant successes of this theory: the quantitative calculation of the spectrum of hydrogen, the theory of the fine-structure of

the lines in the spectrum of ionized helium, of the Stark and Zeeman effects, and of many matters connected with X-rays. Sommerfeld's masterly book on atomic structure shows to what an extraordinary extent the theory has widened our horizon. After one swallows the bitter medicine composing its fundamental postulates, it is evident that one feels immeasurably better. An ordinary spectrum appears in an altogether new light, with its complexities very greatly reduced in number, being those only of the various energy levels. Many of these can be explained by bringing in precession in the electronic orbits and taking account of changes of mass due to motion according to the theory of relativity.

I should like to apply the brakes for a moment, to help overcome a slightly dizzy feeling, and gaze upon the structure which is here presented. Consider, for example, the relatively simple atom of magnesium. Two of its electrons are coupled closely to the nucleus and presumably describing small orbits about it. Outside of these lie eight more, in orbits oriented in space with a sort of cubical symmetry; and beyond these again are two others, describing rather elliptical orbits, penetrating during each voyage around the nucleus into the internal tangle composed of the rest of the orbits, and being thrown thereby into a processional sort of motion whereby the same path is not exactly followed in successive revolutions. A radiant magnesium atom has had one of its outer electrons removed by some accident to a more distant orbit from which it returns to its normal position by one or more discontinuous jumps, a gradual return being supposed not to be possible.

This model is a beautiful product of the human imagination, a piece of scientific poetry of the highest art. Moreover, it has achieved such marked success that it must in many important respects be true and correct. Under these circumstances any criticism of the theory must be cautiously made, and with full acknowledgment of the fact that purely destructive criticism has but little value in itself. Nevertheless, it is interesting to consider certain aspects of this atomic model that seem to be somewhat incomplete.

Much thought is now being expended on the problem of harmonizing this planetary type of atom model with the more or less static model proposed some years ago by G. N. Lewis and so conspicuously useful in the study of chemical phenomena. In an interesting book on Valence which has just appeared, Lewis himself indicates a way in which this can be done. He would like us to regard the electron's position as given by the orbit as a whole, rather than by the actual instantaneous position of the electron itself in that orbit. He points out, further, that in Bohr's model one electron in revolution is apparently unable to act upon another with the force which one would expect it to exert if the two happen to come near one another, but that we shall have to suppose, if I understand him correctly, that the action of the electron takes place from its average position rather than its position at any instant. This sounds very much like regarding the electron, at least while we are considering its perturbing effect, as though it were spread uniformly over the whole circumference of its orbit, in other words, as an elliptically-shaped ring. Such electrons might then be thought of, except for their magnetic effects, as static, and the important differences between the two points of view begin to show signs of disappearing. On the other hand, many objections may be brought forward against the conception of ring electrons as large and curious as these would have to be. The results of experiments on scattering, the phenomena of radioactivity and of ionization seem difficult to account for on this view.

It seems to be necessary, as Lewis points out, to suppose that the electrons in revolution generate magnetic fields in the familiar way. It is by no means evident that a single electron must produce effects of the same sort that myriads of electrons are observed to give. We are, perhaps, prone to push analogy too far. The beautiful experiments of Stern and Gerlach, however, in which silver atoms disclosed their magnetic moments, give a sense of reality to atomic magnetic fields that they did not possess before. These fields must have an important part to play in orienting the electron orbits with respect to each other, which seems not to have yet been very fully considered. Also, a conservatively-minded person finds it odd to have to retain the magnetic field produced by a revolving electron, while denying the existence of any radiation emitted by it in a steady state. A ring electron is again indicated as the only easy way of harmonizing these two ideas.

There is evidence of an important property of the electron of which but little account seems to have been taken in Bohr's theory. I refer to the tendency, at least in the presence of an atomic nucleus, for the electrons to form in pairs. Lewis mentions several indications of this sort; the stability of the helium atom suggests itself as an example. Other bits of evidence pointing in this same direction will be mentioned presently. As Lewis shows, a magnetic field associated with each electron gives us a very convenient way of pairing them off, after the manner of two magnets, which, when free to move, make as intimate a combination as possible by coming close together. If the magnetic properties of an atom reside largely in its outer electrons, as there seems now to be some reason to believe, it is not apparent how Bohr's atom model makes any use of this pairing action. Of

course, the nature of the electron itself must be closely studied in the hope that it will yield the cause of this remarkable effect.

We must not forget how incomplete our knowledge still is of the electron. Sir Oliver Lodge has recently suggested the possibility that light may generate electrons. One might put in the same category the suggestion that "excited" electrons in atoms may be different from normal ones; or that they may cease to be indivisible when engaged in radiating. However that may be, we may safely pin our hopes upon the electron, in the expectation that when its nature is better known we shall at the same time have a clew as to the nature of radiation, and the reason for quanta of energy. Speculations on these matters in the present state of our knowledge may well be a waste of time, but in the long run something important is likely to result from such an exercise of the imagination.

We need badly some picture of how the vibratory features in radiation are produced. A quantum of energy emitted appears as a train of waves. Apparently no one is yet able to do without these waves. Certainly no teacher who has to present to his students the phenomena of interference and polarization and their simple explanation on the wave-theory will be willing to abandon this idea without a struggle, no matter how badly it may fit with the facts of photo-electricity, etc. But there is no mechanism in our atomic model which appears to vibrate, and some would prefer to leave us no medium in which the vibrations might travel. Can the electron orbits be made to serve? The frequency of revolution looks promising, agreeing as it does in extreme cases with the frequency of the emitted radiation. Certainly it seems painful to conceive, as C. G. Darwin puts it, of an electron with a knowledge of the future, so that while leaping from one orbit to another it determines in advance the frequency with which it would be appropriate to radiate, taking into account its final destination. This is less physics than metaphysics.

Let us not give up the hope that our present atomic model will be somewhat simplified and that one may some day be found that will fit the facts without invoking the aid of so many non-mechanical processes. It is perhaps in this connection a little cheering to note that whenever established mechanical principles are useful in explaining the behavior of electrons in atoms, they are freely used. There is in the correspondence principle an admission that they lead us to the neighborhood of the truth, if not exactly to the truth itself.

Releasing the brakes now, for a moment, we can not fail to admit that the adoption of so much that violates classical mechanics has brought us very considerably forward and that, since we must progress at all costs, this may after all be the only possible way.

Leaving now the game of atom-building, let us gaze again upon those humble toilers, the experimental spectroscopists, who have all this time been busily grubbing about in the terra firma of observation, and have after all succeeded in raising from their labors the very considerable crop of facts upon which the theory has been nourished. Recently their numbers have been swelled by the addition of many workers, and many of the highest ability. As a result, important advances in our understanding of the structure of spectra are appearing now each month. The discovery of multiplets by Catalan has inspired a number of courageous souls to attack the more complex spectra, and it will not now be long before such as Fe, Mn, Ti, etc., must yield their secrets. The working rules for the structure of complex Zeeman patterns given us by Landé add enormously to the value of this phenomenon in furnishing us with a key to the structure of spectra.

In addition to such major attacks, minor sallies have been made against the lesser difficulties, some of which have disclosed matters of interest in connection with atomic theory. One of these, in which H. N. Russell and I have been interested, has been concerned with those curious groups of six lines which occur in the spectra of Be, Mg, Ca, etc., and have become known among spectroscopists as the pp′ groups. These are formed, in the language of the Bohr atom, by an electron jumping to the lowest of the triplet p levels, or orbits (which are involved in the production of the strongest triplets in the spectrum), from some other triple levels which appear to have no connection with the series structure of the spectrum.

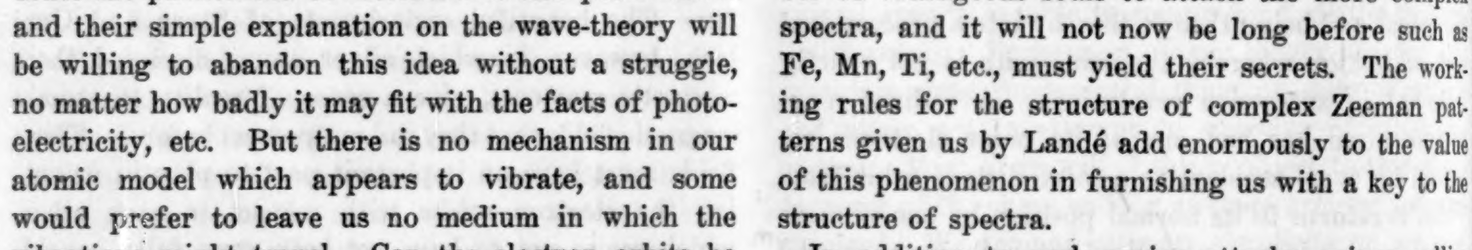

FIG. 1.

We are now able to show, through the recent discovery of three new groups of this sort in the Ca spectrum, that these groups belong in a spectrum series of their own, but that the "terms" (numbers proportional to the energy in each level) of some of them are negative. This means that more energy is emitted, when these jumps occur, than the electron possesses. The simplest source for this extra energy seems to lie in the other electron, hitherto supposed to be inactive during this process. We have merely to suppose that the second electron also makes an appropriate leap and supplies the deficiency of energy. This involves a nice degree of cooperation between the two electrons, whereby the atom as a whole loses a quantum of energy due to changes in two of its parts simultaneously. Such team work has appeared before in the emission of band spectra from molecules, but seems hitherto not to have been supposed to be associated with atoms. Perhaps another and a better explanation may be found; but, in any case, the occurrence of such lines as these with great intensity indicates that the event which produces them is a common one.

Among the most remarkable consequences of the new theories have been the connection which they have given us between phenomena at first sight unrelated. Who could, for instance, have supposed a few years ago that we might now be getting definite ideas about specific heats and molecular moments of inertia from a study of the lines in band spectra? Let us pause a moment over another such matter, the ionization potentials of the elements. The Rutherford-Bohr atom gives us a definite picture of the process of ionization by impact with a wandering electron. Experiments to measure the potential through which the impinging electron must fall in order to ionize the atom were begun many years ago, and have been very successful. Certain difficulties present themselves, however, especially in making due allowance for the initial speeds of the electrons, and in some cases in determining in just what stage of ionization or dissociation the atom or molecule is left after the impact; and these have been the cause of undue variations among the observed values. Bohr's theory gave us an immediate connection between the most important series in the spectrum of an element and its ionization potential. According to this theory the electron must be removed from the atom by an impact before it or some other electron is recaptured and allowed to fall in to the lowest possible level, thus causing the emission of the spectrum lines. The energy eV given to the electron by a fall through the ionizing potential must be equal to $h\nu$ where ν is the frequency of the limit of the most important series in the spectrum, *i.e.*, the highest frequency that could be emitted by the atom. Now these series may be found by purely spectroscopic observations, and the calculated potential thus compared with that directly observed by bombarding atoms with accelerated electrons until they are ionized. The odds are in favor of the spectroscopic results. Witness their recent triumph in the case of He, where the discovery of the right series by Lyman disclosed an error of 0.8 volt in the hitherto accepted value.

Recently additional data on ionization potentials have been accumulating at such a rate that it now seems profitable to look for a moment at the curves

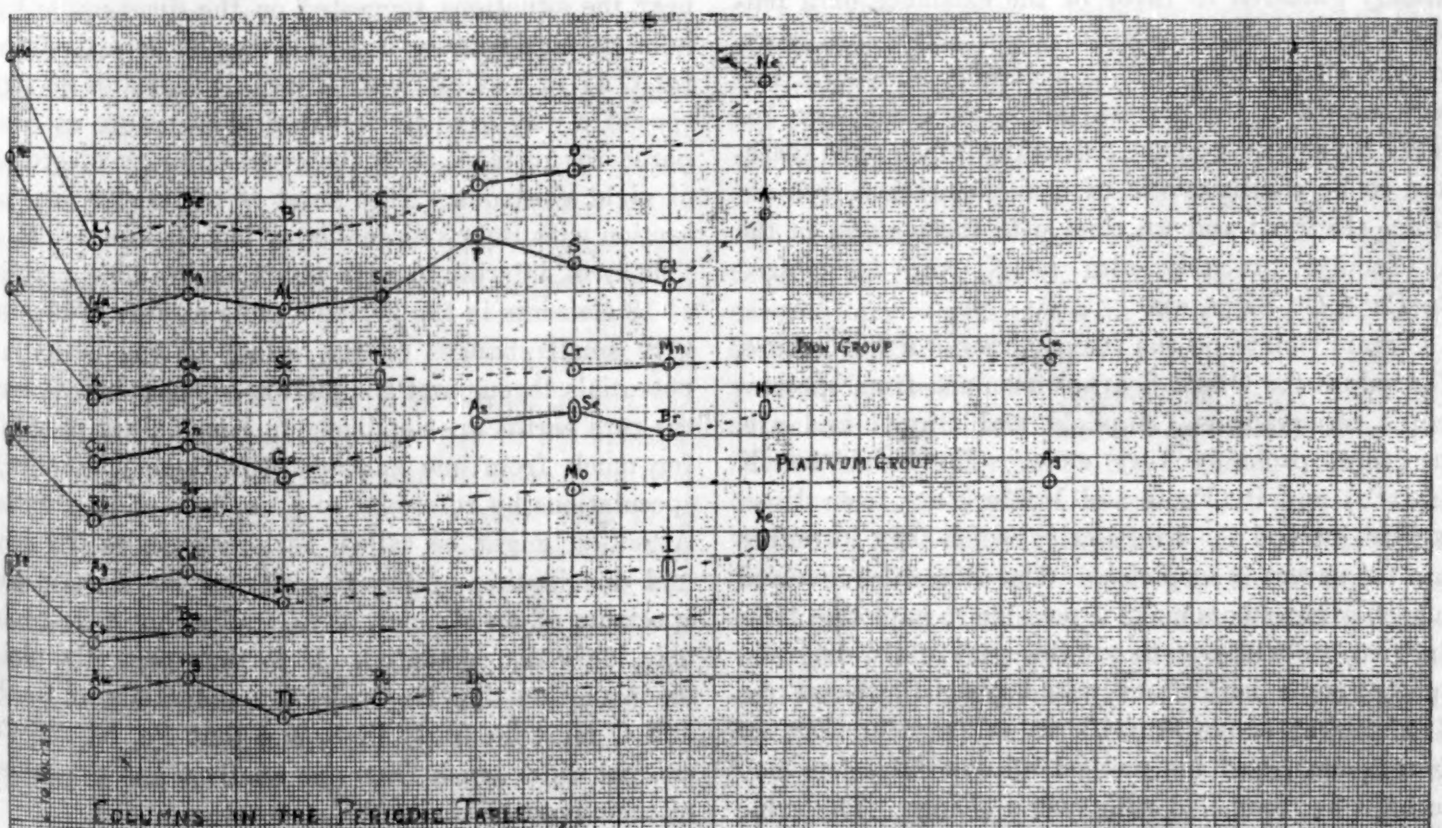

FIG. 2.

showing the variations of this quantity with the atomic number of the elements. No originality is claimed for this mode of presenting them; it has already been used by Catalan, and perhaps by others. As has happened so often before, it is in the air. Such a curve is presented in Fig. 1. In this figure you may be more conscious of the gaps than of the points that are filled in. Fig. 2 shows a grouping of the same points arranged according to the periodic table of the elements, *i.e.*, all the elements of the first column are shown at points whose abscissae are 1, the abscissae thus standing for the number of outer, or valency, electrons in the atom. The scale of volts (ordinates) has been kept the same throughout, but its origin shifted arbitrarily so as to prevent the curves from falling upon one another, and to bring out similarities in form.

Several conclusions can be drawn from these curves. First, of course, is shown the extraordinary stability of the inert gases, and next the ease with which the atom immediately following each one can part with its external electron. In passing from columns 1 to 2 one is struck by the parallelism of the lines, and the ionization potential of Be may be predicted from this diagram with what would seem to be a reasonably small error. Although the gaps prevent one from drawing any exact conclusions, it would appear that there is on the whole a rise of ionization potential with the number of external electrons between one alkali metal and the next inert gas, with, however, in several cases an alternation, giving a zig-zag appearance to the curve. If this alternation is real, it furnishes a bit of evidence to add to the many others already gathered in favor of the existence of a tendency for the electrons to form themselves into pairs, so that a third or a fifth is a distinct outsider. The very nature of the spectra points the same way, for in the Na family we have pair series which seem therefore to be characteristic of a single, rather free external electron; and we meet with these again in the Al family, probably also in N, and in ionized $Ca(Ca^+)$, C^+, Si^{+++}, etc.

Certain points on the curves deserve a word more. The values for O and S are determined from spectroscopic observations (Hopfield and Birge) and are, therefore, probably very close. The value for N (Smyth) and P (Foote and Mohler) are from direct experiment and the irregularity which they introduce into the curves is suspicious. The difficulties involved in such experiments make it possible to hope that later observations will smooth out this part of the diagram. Spectroscopic indications would place the point for N somewhat above Smyth's value (say 12 volts or thereabouts), and his method of determination may perhaps be reconciled with such a change. The value for P is by analogy with recent work on N probably the ionization potential of the molecule rather than of the atom. One would not anticipate a value for the P atom which was higher than that for N. The points for Cr, Mn and Mo are from recent work by Catalan; for Au from Thorsen's recently discovered series; for Ti from unpublished work by Russell. In some of these cases the value is uncertain within a small range, indicated on the diagram. The points for A, Kr and Xe are from a very recent paper by Sponer, and that for Bi from a note just published by Foote and others in *Nature*. This same note indicates that the point for As should be placed a little lower. The point for Se is suspicious; one would expect a lower value for this element than for O and S.

The ionization potential of Si entered on this curve is intended to lie between 7 and 7.5 volts, with a probable value near 7.2. It is determined from observations on the spectrum, which show that there occurs in Si a persistent line at λ2881 bearing all the signs of being an "ultimate" line and the first member of the principal series of singlets of this element. The second member should lie in a region in which one suitable line occurs, and one only, at λ2124. A third line of this series has I think also been found. Mr. W. J. Cahill is working in the Jefferson laboratory on several of these spectra, and we hope to be able to confirm this new series shortly, as well as to give definite values to the points dotted in vaguely on the graph from spectroscopic indications for Be, B and C. Observations on these elements have disclosed a number of new lines that appear to belong to the normal atom. The present indications would fix the points near the situations suggested on the diagram, and it is interesting to note that if the value here predicted for C (7 to 8 volts) is confirmed, it indicates no very special strength in its tetrahedral structure as compared for instance with the great stability of groups of eight electrons. This point is of interest in connection with Bohr's discussion of the electron orbits.

It is of interest to note also that the long periods of 18 elements in the periodic table appear to involve very small changes of the values of the ionization potentials throughout the middle of their length, and the rare earths are not likely to have values that differ much from one another. One may check such speculations by reference to a number of other facts. Attention might be called, for instance, to the general distribution of the majority of the lines in the spectrum of an element, as an indication of its probable ionization potential. It is thus perfectly plain on inspection that the ionization potentials of Be, B and C must be fairly high, and that Fe, Ni and Co can not differ much from one another, and the values of their potentials must be moderate.

The study of the more complex spectra is yielding approximate values for ionization potentials in a few cases, and also a picture of the way in which the complexities of spectra increase in passing across the periodic table. With Professor Russell's kind permission I mention a conclusion to which he has recently come, to the effect that the complexities run as follows: in column I all lines are pairs; in II they are singlets or triplets; in III pairs or quadruplets; in IV singlets, triplets or quintuplets; and so forth in a regular manner alternating and increasing across the table. Analogy indicates that the fundamental lines will lie with the least of the complexities, and it is on this ground that the singlets in Si have been assumed to furnish the ionization potential of that element. There are interesting facts now available in regard to the way in which these complexities widen out or shrink in passing down the columns of the periodic table, or across them, or from one element in the normal state to the same in various stages of ionization, or from an ionized element to others containing the same numbers of external electrons (but different nuclei). The facts are unfortunately not quite well enough known to permit much analysis, and there is little theory as yet on these difficult relations.

Another spectroscopic aspect of the atomic problem is furnished by the new atoms created by the removal of one or more electrons. These are temporary atoms, but their spectral similarities (*e.g.*, Al^{++} and Mg^{+} with Na, Al^{+} with Mg, etc.) tell us something about their probable chemical properties, and their spectral series yield their ionization potentials. Their occurrence offers a number of attractive puzzles as yet almost untouched. They appear, for instance, to have the ability to form temporary compounds, whose existence may sometimes be proved from band spectra. Somewhat similar is the occurrence of molecules in *He* which are supposed to be formed by "excited" atoms, *i.e.*, those in which one electron is displaced from its innermost position to an outer orbit.

Much praise is due to Fowler and to Paschen for their recent work on the spectra of ionized Si and Al. Paschen found it possible to sort out in the spectra furnished by sparks and other sources those lines due to Al, to Al^{+} and to Al^{++}, and to show that they form systems of series requiring four times the universal series constant N for the atom Al^{+} and 9N for the series formulae of Al^{++}. Fowler found in Si^{+++} series requiring 16N, thus furnishing a striking confirmation of a prediction originally made by Bohr.

Finally, in the direction of very short wave lengths, experiment has recently blasted out new trails which will doubtless lead us to much that is of the greatest interest. The work of Lyman, Millikan and many others is disclosing the most important radiations of many atoms, and much more needs to be known, especially about series spectra in this region, to bring about a closer connection between optical and X-ray series in the lighter elements. This is probably, to quote a happy phrase of Professor Russell's, the heroic age of spectroscopy, and in the next few years we may hope to have laid a thoroughly sound foundation for future builders of atomic models. Not until then at least shall we have begun to emerge from the darkness of ignorance in which we are still plunged, or to have begun to deserve the name imposed somewhat prematurely upon our species—Homo sapiens.

F. A. SAUNDERS

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ON CERTAIN COURSES NOT LISTED IN THE MEDICAL CURRICULUM[1]

EDUCATION in medicine has changed greatly since the war. Practically all the good medical colleges have found it necessary to limit the numbers of their students on account of the increasing masses of men and women who seek admission to the various institutions of learning. This has made it possible for us here at Cornell to select only those who have the best educational and personal qualifications. This selection is difficult, but the dean and secretary have acquired great skill and we are becoming accustomed to increasingly enthusiastic reports from the teachers of the first-year classes. The medical college secures a much better group of students. The students secure, or should secure, a better understanding of their indebtedness towards the college. Each one of you is virtually receiving a scholarship of approximately one thousand dollars a year, since it costs the university this sum in excess of the tuition fees to furnish the education that the faculty believes to be essential. The expenditure of this sum was made possible through the generosity of the late Colonel Payne, who endowed our medical college. Your acceptance of its benefits entails on your part a serious realization of your obligations to the community. The community expects not only well-educated conscientious practitioners, but also devoted public servants. If in addition your class develops, as we expect it to develop, leaders in the science of medicine, we are more than repaid for the investment of money and the labor of teaching.

The year of 1923 marks a change in the policy of the Cornell University Medical College. The faculty has realized that the curriculum is overcrowded and has decided to reduce the number of hours of instruc-

[1] An address delivered to the medical students at the opening of the college year.

tion. Unfortunately, little change can be made with those classes which started under the old régime, but the new classes will find an increasing number of blank spaces in the schedule. Why should the faculty try to cut down by 20 per cent. the hours of instruction, when the science of medicine is becoming more and more crowded with facts that the students must learn?

During the last few years, as these facts have increased in number, the teachers of medicine have increased the rate of cramming the students. This has developed the method of "spoon feeding." Our students resemble domestic fowls fattening for the market, expecting their food to be served to them in trays. We should prefer to have game birds who know how to find their own food. You can take all the courses listed in the catalogue, work hard, pass your examinations, and yet make an utter failure of your course in the medical school. The best that we can teach you now will be hopelessly inadequate in another decade. *You must teach yourself to study the medicine of this decade in such a manner that you can teach yourself the medicine of the next decade.* You must learn to do your own searching for knowledge. You must develop your own powers of observation and critical judgment. You must learn how to use the literature and must prepare yourself to substitute your own wards, your own laboratories and your own libraries for those of this medical school.

In the hope of accomplishing these ends the faculty is leaving blank spaces in the schedules. Although it has never been expressed in words, I feel sure that the faculty has intended that these vacant hours should be filled not only by electives but also by certain fairly well-defined courses in self-education, which I shall now endeavor to outline. These are all to be conducted by Professor Ego assisted by Dr. Subconscious Self. The periods in many of them are rather long, sixteen hours a day, seven days a week. The examinations last only a lifetime.

The first of these courses is entitled "How to study." You have had some preliminary training in school and college, but you are now met by sterner demands. You will find that enormous numbers of facts must be learned and that glittering generalities play a minor rôle. The manner in which these facts can best be impressed upon your memories is left largely to yourselves. Each one of you must find out for himself how he individually can study best. Some learn best from books, some from hearing. Some learn best by working with fellow-students and mutual quizzing. It has always seemed to me that the most economical and soundest method is to learn through observation, and by this I mean interested, concentrated, intelligent observation of the objects presented to you in laboratories and clinics.

The second course, and one of the most important, is entitled "What to remember and what to forget." Your success in it will depend largely upon your native ability in judging values. This is the faculty that the business man employs in judging a market or selecting for his store those goods which will find a ready sale. It is impossible to remember everything that you hear or read. When a fact that seems to you to be important is presented, you should record it clearly in your mind, coordinate it with other important facts, fortify it by illustrative examples. If this be done properly it will serve you a lifetime. The process of forgetting things which should be forgotten sounds easy but proves difficult. How can we recognize the statement that is unimportant or incorrect? Often we can make use of our knowledge of the science of heredity and study the ancestry of the statement in question. James Harvey Robinson has presented an excellent point of view in his book, "The mind in the making." He shows that our thoughts, and particularly our subconscious thoughts, are influenced by our animal heritage, our savage mind, by the period of medieval civilization and by our childhood. He infers that in scientific investigation only have we cut ourselves loose from this intellectual ancestry. This has been done successfully, however, only in the best scientific investigation, and we still have in our medical literature and thought many vestiges of by-gone ages. This can be appreciated only if you dip into the medical books of previous generations and study the history of medicine. Our journals and even some of our text-books contain unverified statements from authors who used incorrect methods and thought in terms which are incompatible with our present knowledge. These pitfalls are dangerous, but not as dangerous as the entanglements of some modern investigators, who talk our modern language, but run after the ancient gods of poor technic, artifact and unwarranted theory. In browsing through the literature the student should scrutinize the parents and sponsors of every statement. An article by an unknown author, from an obscure town, published in a mediocre journal, may contain accurate information, but the chances are ten to one against it. An article in a good journal, by a well-known man, who has on previous occasions wandered after strange gods, should be regarded with suspicion. Even the best of men, including almost all medical teachers, have their hobbies and ride them too hard. Fortunately, students are particularly skilful in detecting this more or less innocent form of amusement in their instructors.

Why is it important to forget these misstatements, exaggerations and errors? They seem to do no harm if they are tucked away in our minds with a label of "doubtful" or "erroneous." The trouble is that they

wander into the subconscious and often mix our thoughts for years to come. The man who knows about a given subject only five things that are really so is much better off than the man who knows ten facts that are true and ten "facts" that are not true. Each "fact" that is not true distorts all the facts that are true. I am inclined to believe that a formula for a man's effective knowledge concerning a given subject could be expressed as follows: The number of true facts divided by the square of the number of untrue "facts."

A third course is entitled "How to express what you know." In this course 80 per cent. of our students have been failures. Reading over examination papers, I have been horrified by the jumble of ideas that pours out of the swiftly moving fountain pens. The facts may be given, but they are presented in hopeless confusion. The student plunges into the middle of the subject, then demolishes the end and finally, if he happens to remember, hurriedly jots down the all-important beginning. One of the most common faults is to write down a heterogeneous mass of statements which has nothing to do with the question. Some of these are truths, some half-truths, but usually we find that there is no truth in them. One year in the examination in medicine we asked the fundamental cause of ketosis in diabetes. This was the last question on the paper and most of the industrious students used all their spare time in long discussions. One man had only a minute left for the question and he wrote "The cause of ketosis is the inability to oxidize carbohydrates." That was all he wrote; that was all he needed to write. His answer was the best of the lot.

The blank hours in the schedule will, for the first time, leave room for a course which seems to me to be of great importance. This is a practical course in the care of your own bodies. Many of you have been accustomed to athletics and regular exercise. The medical student in a city like New York often drops this suddenly, and his health and work suffer in consequence. We preach the necessity of fresh air and exercise to our patients, but give our students no time to apply our teachings. I wish to take this opportunity to call to your attention the branches of the Y. M. C. A. which are scattered throughout the city. I wish to warn those who are working their way through college that there is no point in securing a doctor's degree for a physical wreck. I believe that many of our students suffer permanently from studying too late into the night. A brain that is tired and sleepy works inefficiently and this causes a vicious circle. You must decide the question for yourselves, but I suggest regular hours of sleep, regular hours of exercise, and intensive hours of study with a brain at its highest efficiency instead of long hours devoted to reading over and over again pages which make little impression.

It seems to me that there should be a distinct place in your curriculum for a course "in the joy of life with excursions into the realm of youth." This used to be the chief occupation of the medical student a few generations ago. Now you seem to have gone to the opposite extreme and have become prematurely aged. There is no particular reason why the four years of medical study should be bereft of all joy and made into the bitter experience upon which many of us look back with horror. Our dean has recognized this fact and has given this course "in the joy of living" an official place in the college schedule. I refer to that day in the springtime when the faculty and students meet on equal terms of youth. On this one day of the year the instructors became almost as young as their students who sometimes actually beat them at baseball, though I doubt if they would do quite as well at tennis or golf. Our spring "Get Together" is the happiest day of the year, but there is no reason why it should be the only happy day. Stay young while you are still in your twenties. They say that it becomes difficult in the fifties.

It is of vital importance to stay young if you wish to succeed in the most important of all the courses that are not listed in the catalogue. This course might be called the "Seeing of visions." "Where there is no vision the people perish," says the writer of the Book of Proverbs. Unless the medical student is able to look forward to something bigger and better than the existence of the average man or the average practitioner of medicine he will scarcely be repaid for his years of labor.

Different individuals will, of course, have different visions of the goals they wish to attain. The faculty of seeing ahead and dreaming of great things develops as a result of stimuli from without, but chiefly as a result of inward growth. Therefore, it is necessary for you to grow as men and women, as servants of the public welfare and as leaders of men. You must learn to accept responsibilities and train yourselves to join the ranks of those having authority.

Leadership on your part is not a voluntary matter. It is an obligation which should be realized from the very beginning. In trying to find the best words in which to express this I have gone back to the time when the world was young, when Homer wrote the story of the battles of the Trojan Plain. You may remember Sarpedon and Glaucus, royal allies of the Trojans, are about to lead their troops against the strong Greek wall. Sarpedon says:

> Why, Glaucus, are we honored, on the shores
> Of Lycia, with the highest seat at feasts,
> And with full cups? Why look men up to us

As to the gods? And why do we possess
Broad, beautiful enclosures, full of vines
And wheat, besides the Xanthus? Then it well
Becomes us, foremost in the Lycian ranks,
To stand against the foe, where'er the fight
Is hottest; so our well armed Lycian men
Shall say, and truly: "Not ingloriously
Our kings bear rule in Lycia, where they feast
On fatlings of the flock, and drink choice wine;
For they excell in valor, and they fight
Among our foremost." O my friend, if we,
Leaving this war, could flee from age and death,
I should not be here fighting in the van,
Nor would I send thee to the glorious war;
But now, since many are the modes of death
Impending o'er us, which no man can hope
To shun, let us press on and give renown
To other men, or win it for ourselves!

This responsibility and obligation is perhaps best realized by one group of students with a vision clearly defined when they enter the medical school. I refer to the men and women who are preparing themselves to become medical missionaries. In this group one feels that the work has been lifted out of the rut by the buoyancy of the high spirit in which it is undertaken. It is difficult to imagine a loftier cause to which a man may offer the devotion of his life. Here in this country we help our hundreds of patients who could find another doctor around the corner. In Asia and Africa the medical missionaries help the thousands, the millions, who have no other touch with Christ's teachings and no other means of receiving the benefits of the civilization that has developed only in Christian communities.

Those of us who intend to remain in this country must aim high to approach the vision of these medical missionaries. If we intend to work as practitioners of our science and art, we must not only perfect ourselves in our knowledge of the science, but we must also develop to the utmost all those higher senses which will aid us to do good for the sake of doing good. We must defend ourselves against the sins of laziness, carelessness and avarice, and in defending ourselves, we can not do better than to remember the old adage of the U. S. Navy, "The best defense is the rapid and well-directed fire of your own guns." The best defense against the sins that I have mentioned is the rapid and well-directed effort to do good in your own community.

There is another vision which I would like to call to your attention, since it is particularly well adapted to all of you who are receiving the benefits of a training at Cornell. I refer to a career in academic medicine and research. Throughout the land far-seeing philanthropists are endowing medical schools and institutions of learning. These are helpless without well-equipped teachers, and the supply of such teachers is becoming inadequate. A life devoted to medical teaching, and particularly to the teaching of the fundamental sciences, entails a sacrifice of many of the pleasures that accompany worldly goods, but the harvest is reaped by the community and by all that is best in the man himself.

Far be it from me to attempt to dictate your visions. You must find them yourselves. I can only suggest one method of procedure. Set your goal as high as possible according to your own lights. Then study the best, the finest man you know and try to understand the goal that he would have you attain. Even this is incomplete unless you seriously consider what our Master, Jesus Christ, would expect of a man of your opportunities. The writer of the Psalms has said, "Good luck have thou with thine honour; ride on, because of the word of truth, of meekness and of righteousness; and thy right hand shall teach thee terrible things."

EUGENE F. DUBOIS

CORNELL UNIVERSITY MEDICAL COLLEGE

SCIENTIFIC EVENTS

BAYER 205

THE Berlin correspondent of the London *Times* writes that a new stage has been reached in the struggle against sleeping sickness, for Bayer 205 has been tested in Central Africa and has been proved beyond dispute to surpass in its effectiveness any remedy that had previously been tried. The new compound discovered by the Bayer Chemical Works in Leverkusen, near Cologne, is extremely complicated and contains neither arsenic nor antimony; only carbon, nitrogen and hydrogen enter into its composition. Like salvarsan, it is ultimately derived from atoxyl, and as salvarsan bore the number 606 so Bayer was christened 205 because 205 successive transformations of the original substance, atoxyl, were made by the Bayer chemists before the Bayer medical staff pronounced the result satisfactory enough to merit practical experiments. From first to last ten years were occupied in its production.

In 1919 the remedy was passed on to Professor F. K. Kleine, director of a department in the Robert Koch Institute in the study of infectious diseases in Berlin, with a view to his carrying out experiments in Central Africa. Dr. Kleine had studied the trypanosome diseases for many years in German East Africa, now Tanganyike Territory. In earlier cases he had acted as Koch's assistant. Together the two experimented with atoxyl in the Sesse Island of Victoria Nyanza.

In the autumn of 1921 the British Government granted permission for Dr. Kleine and his colleague Dr. Fischer to proceed to Northern Rhodesia. A

camp of wooden huts with straw thatches, including a laboratory and clinic, was built at a native village in the neighborhood. This formed the base of operations for the first year while Dr. Fischer toured the native districts, accompanied by a government courier, in search of patients.

In the autumn of 1922 the party crossed into the Belgian Congo, on the invitation of the Governor-General. The disease is more widespread in the Congo, and a profitable year was spent at and around Elisabethville.

It may be recalled that the chief epidemics caused by trypanosome in Tropical Africa are sleeping sickness in men and nagana in cattle. Trypanosome are small flagellates, in the language of biology, which live in the blood of infested organisms. They are conveyed by the sting of the glossines, a family of stinging flies which is only found in Africa. The trypanosome undergo a series of transformations inside the insect. They stand in the same relation to the glossines or tsetse flies as the malaria parasites to the anopheles.

An all-important matter to the African stock-farmer is that he should be able to move his cattle across the so-called "fly belts" to and from tsetse-free areas with the knowledge that they will not fall sick on the road if bitten by the fly. Dr. Kleine found that injections of 205 did not act as a certain preventive.

On the other hand, there was a remarkable difference between cattle which had received treatment and cattle which had not. While the latter wasted away and died, the former remained in good condition and could be used for slaughter, even if the tsetse fly had introduced parasites into their blood. A far greater degree of success was obtained in the direction of sleeping sickness. In Rhodesia and the Congo 180 native patients suffering from various stages of the disorder received injections of Bayer 205. In the early stages of the disease a striking improvement was shown after a few injections had been made. The swelling of the glands quickly subsided and the old feeling of health and strength began to return. Most important of all, the trypanosome disappeared from the blood and were proved in the majority of cases, under careful examination of several months' duration, never to have returned.

THE FRENCH PHYSICAL SOCIETY

THE Société Française de Physique celebrated the fiftieth anniversary of its foundation in December. From an article in *Nature* the following notes are taken.

The exhibition, which has hitherto been held by the society at Easter, was this year combined with a wireless exhibition. It was on an unusually large scale, the Grand Palais in the Champs Élysées, in which the annual Automobile Show is held, being used for the purpose. The exhibition was characterized by many demonstrations, more or less popular, which were very attractive.

The anniversary lectures were given at the Sorbonne, the first on December 8, by Colonel Robert, on the relations of physical and technical aeronautics.

On December 10, an attraction of another kind presented itself in the general meeting of the International Union of Physics. The chair was taken by M. Brillouin with Professor H. Abraham as general secretary. The business was largely formal, the main item being the adoption of the statutes. After some discussion as to whether the value of the franc for the contributing countries should be taken in the French or Swiss currency, the former was adopted, notwithstanding the reduction in the contributions by so doing. The date of the next meeting of the union was fixed for the year 1925, the normal three years' interval being reduced, and the question of an international congress will then be decided.

On Monday evening a lecture was given by Professor H. A. Lorentz on the old and new mechanics. The motion resulting from the impact of two balls was considered, and generalized equations were obtained which were applicable to two observers in relative motion. This was followed by the gravitational deflection of light, and a discussion of the quantum theory and kindred subjects.

On December 11, Lord Rayleigh gave an account of his investigations on iridescent colors in nature. He dealt successively with the colors observed in light reflected from potassium chlorate crystals, mother-of-pearl, Labrador felspar and scarabee.

At the conclusion of the lecture Professor Volterra presented, on behalf of the Accademia dei Lincei, two volumes of the collected works of Volta. Other volumes are in preparation.

December 12 was marked by a banquet at which the delegates were royally entertained. The chair was occupied by the under secretary of state for public instruction. M. Picard (president of the Société Française de Physique) welcomed the foreign delegates, and responses were made by Professor Volterra, Professor Lorentz, Lord Rayleigh, Professor Störmer and Professor Knudsen.

The culminating point in the celebrations came on Thursday afternoon, when the chair was taken by the president of the republic in the large amphitheater of the Sorbonne. There were also present the ministers of commerce, of public instruction and of public works. After speeches by M. Picard and M. Brylinski (president of the French electrotechnical committee), Professor Lorentz presented the addresses which had been brought by the delegates. After this

part of the ceremony came a speech by M. Bérard (minister of public instruction), followed by remarks by the president of the republic. Professor C. Fabry then lectured on the domain of radiations.

Lectures by Professor Störmer on the aurora borealis, on December 14, and by Professor Knudsen on the mechanism of evaporation and condensation, on Saturday, brought the celebration to a close.

REPRINTS FROM ANNUAL TABLES

The Secretary-General of Annual Tables announces that the following list of reprints from Volume "IV" is available:

Spectroscopy, by M. L. Brüninghaus. Preface by A. Fowler, F.R.S.

Electricity, magnetism, conductivity of electrolytes, electromotive forces, by MM. Malapert, v. Weisse, R. E. Slade and G. L. Higgen. Preface by F. B. Jewett.

Radioactivity, electronics, ionization of gases, etc., by MM. J. Saphores and F. Bourion. Preface by Sir E. Rutherford, F.R.S.

Crystallography and mineralogy, by L. J. Spencer. Preface by Sir Henry A. Miers, F.R.S.

Biology, by E. Terroine and H. Colin. Preface by Jacques Loeb.

Engineering and metallurgy, by L. Descroix. Preface by G. K. Burgess.

Colloids, by E. Rebière. Preface by Jacques Duclaux.

These reprints contain all the data for the subjects indicated which are found in Volume IV of the Annual Tables, which volume covers the literature of the world for the years 1913 to 1916 inclusive. Specialists having occasion to refer frequently to data in the fields covered by any of these reprints will find them invaluable for ready reference. Members of any of the organizations listed below are entitled to a 50 per cent. discount on the regular prices:

National Academy of Sciences.
Philosophical Society of Washington.
American Philosophical Society.
American Academy of Arts and Sciences.
American Association for the Advancement of Science.
American Institute of Chemical Engineers.
American Institute of Electrical Engineers.
American Electrochemical Society.
American Chemical Society.
American Ceramic Society.
American Society of Civil Engineers.
American Society of Mechanical Engineers.
American Society for Testing Materials.
American Institute of Mining and Metallurgical Engineers.

PUBLIC LECTURES OF THE HARVARD MEDICAL SCHOOL

A series of lectures under the auspices of the Harvard Medical School opened on Sunday afternoon, January 6, at four o'clock, and will be continued until May. The lectures are as follows:

January 6—*Present-day conceptions of mental disorder:* Dr. Macfie Campbell.

January 13—*Some of the causes of bladder trouble:* Dr. J. Dellinger Barney. (To men only.)

January 20—*Smallpox and vaccination:* Dr. Benjamin White.

January 27—*Conservation of eyesight:* Dr. George S. Derby.

February 3—*What can we do to prevent heart failure?* Dr. William H. Robey.

February 10—*On the various types of thyroid disease and their significance to the individual and to the community:* Dr. James H. Means.

February 17—*The relations of exercise to health:* Dr. William H. Geer.

February 24—*The contagious diseases of the skin and possible measures to avoid them:* Dr. Charles J. White.

March 2—*Pain and anesthetics:* Dr. Charles A. Brackett.

March 9—*Diabetes and insulin:* Dr. Elliott P. Joslin.

March 16—*Blood:* Dr. Lawrence J. Henderson.

March 23—*Some surgical conditions common among children:* Dr. James S. Stone.

March 30—*Successes and failures of surgery:* Dr. David Cheever.

April 6—*Modern obstetrics:* Dr. Franklin S. Newell. (To women only.)

April 13—*The question of the specific treatment in tuberculosis:* Dr. Hans Zinsser.

April 27—*Catarrh:* Dr. Harris P. Mosher.

May 4—*Syphilis:* Dr. George A. Dix.

THE AMERICAN PALEONTOLOGICAL SOCIETY

The fifteenth annual meeting of the Paleontological Society held at Washington, D. C., December 27–29, 1923, was attended by 60 members and a number of visitors. Eleven new members and three foreign correspondents were elected, making a total membership list of 239.

The address of the retiring president, Dr. T. Wayland Vaughan, on "Criteria and status of correlation and classification of Tertiary deposits" was delivered in joint session with the Geological Society of America as were also thirteen papers on stratigraphic geology. Thirteen papers on the various branches of paleontology were presented before the society, but the main feature of the meeting was a "Symposium on the correlation of the Tertiary formations of southeastern North America, Central America and the West Indies with the Tertiary formations of Europe," in which eleven members of the society took part.

The officers elected for 1924 were as follows:

President, E. W. Berry, Baltimore, Maryland; *Vice-presidents*, E. H. Barbour, Lincoln, Nebraska, Frank

Springer, Washington, D. C., and F. M. Anderson, Berkeley, California; *Secretary,* R. S. Bassler, Washington, D. C.; *Treasurer,* Carl O. Dunbar, New Haven, Connecticut; *Editor,* Walter Granger, New York City.

Following the meetings, members visited the paleontological laboratories of the U. S. National Museum and made a field trip to study the local geology.

R. S. BASSLER

THE TORONTO MEETING OF THE BRITISH ASSOCIATION

THE British Association for the Advancement of Science will hold its annual meeting at Toronto from August 6 to 13 next, inclusive, and it is hoped that a large representation of scientific men from the United States will attend the meeting. It is understood that an invitation will be extended to members of the American Association for the Advancement of Science to become members of the British Association for the meeting. The indications are that there will be a large attendance of British scientists including many of the best known workers in the various departments. The programs in all sections are being arranged so as to include, as far as possible, papers and discussions on subjects that have recently been under investigation and in several sections joint symposia are being arranged to be taken part in by American and British workers. The various sections are:

A—Mathematics and Physics.
B—Chemistry.
C—Geology.
D—Zoology.
E—Geography.
F—Economic Science and Statistics.
G—Engineering.
H—Anthropology.
I—Physiology.
J—Psychology.
K—Botany.
L—Educational Sciences.
M—Agriculture.

SCIENTIFIC NOTES AND NEWS

THE issue of SCIENCE for January 25 will be devoted to reports of the meeting of the American Association for the Advancement of Science and the national scientific societies meeting with it at Cincinnati from December 27 to January 2.

SIR CHARLES SHERRINGTON has been elected a corresponding member of the Institut de France in the Section of Medicine and Surgery of the Paris Academy of Sciences, in succession to the late Sir Patrick Manson.

DR. G. D. LIVEING, professor of chemistry at the University of Cambridge, from 1861 to 1908, reached his ninety-sixth birthday on December 21. Professor Liveing has been in residence at Cambridge for more than seventy-five years in unbroken succession.

THE American Institute of Chemical Engineers, meeting in Washington, sent, on December 6, a congratulatory message to Professor Charles F. Chandler, that day being the eighty-seventh anniversary of his birth.

THE Royal Meteorological Society presented, on January 16, the Symons gold medal for 1924 to Dr. Takematsu Okada, director of the Central Meteorological Observatory, Tokyo, Japan.

PROFESSOR B. L. ROBINSON, of Harvard University, has been made foreign member of the Societas pro Fauna et Flora Fennica.

THE Paris Academy of Sciences has awarded a prize to Mr. Lee de Forest, the New York engineer, for his invention of lamps with three electrodes used in wireless telephones.

M. COLTON, professor of astrophysics in the University of Paris, has been elected a member of the Paris Academy of Sciences in the section of physics to succeed the late M. J. Violle.

DR. JOHANNES FIBIGER, professor of pathological anatomy at the University of Copenhagen, has been awarded the Jung Cancer Research Prize by the commission of award composed of four members of the faculty of the University of Munich.

JOHN H. HALL, metallurgist for the Taylor Wharton Iron & Steel Co., High Bridge, N. J., and author of publications on steel foundry practice, has received the J. H. Whiting Medal of the American Foundrymen's Association for his outstanding achievements in metallurgy in the steel-casting industry.

THE Radiological Society of North America has conferred a gold medal upon Mr. H. Clyde Snook for his invention of the modern transformer type of X-ray apparatus.

THE A. Cressy Morrison Prize of the New York Academy of Sciences has been awarded to Dr. Frank E. Lutz for his monograph entitled "Apparently nonselective characters and combinations of characters, including a study of the ultraviolet in relation to the flower-visiting habits of insects."

PROFESSOR W. H. HOWELL, of the Johns Hopkins University, as has already been noted, was elected president, and Professor Lester W. Sharp, of Cornell University, was elected vice-president of the American Society of Naturalists at the Cincinnati meeting. The following were elected to membership: O. A. Johannsen, F. H. Knowlton, W. D. Matthew, H. W.

Norris, Wilson Popenoe, Howard S. Reed, Asa A. Schaeffer, W. B. Scott, Charles A. Shull and David White.

C. E. Davis, chief chemist of the National Biscuit Company, was elected chairman of the New York section of the American Chemical Society for 1924 at a meeting held on January 3. He succeeds Dr. Charles A. Browne, recently appointed chief of the U. S. Bureau of Chemistry. Dr. P. A. Levene, of the Rockefeller Institute, was named vice-chairman, and D. H. Killeffer, associate editor of *Industrial and Engineering Chemistry*, secretary-treasurer. The new executive committee is composed of Professor H. R. Moody, College of the City of New York; Professor R. R. Renshaw, New York University; Colonel Raymond F. Bacon, and H. B. Faber, consulting chemist.

Dr. James R. Angell, president of Yale University, has resigned the editorship of the Psychological Monographs of the Psychological Review publications. He is succeeded by Dr. Shepherd Ivory Franz, of the Government Hospital for the Insane, who relinquishes the editorship of *The Psychological Bulletin* to Professor Samuel W. Fernberger, of the University of Pennsylvania.

Dr. Frankwood E. Williams was reelected medical director of the National Committee for Mental Hygiene at the annual meeting of the board of directors, held in New York City on December 28. The following were elected members of the executive committee: Dr. William L. Russell, medical director, Bloomingdale Hospital, White Plains, New York; Dr. Walter E. Fernald, superintendent, Massachusetts School for the Feebleminded, Waverley; Dr. Stephen P. Duggan, director, Institute of International Education, New York City; Dr. William A. White, superintendent, St. Elizabeth's Hospital, Washington, D. C.; Dr. Charles P. Emerson, dean of the Medical School, University of Indiana; Dr. C. Floyd Haviland, chairman, State Hospital Commission, Albany, N. Y.; Dr. Arthur H. Ruggles, superintendent, Butler Hospital, Providence, R. I., and Mr. Matthew C. Fleming, attorney, New York City. Dr. William H. Welch, president of the National Committee for Mental Hygiene, presided.

Miss Ruth Dexter Sanderson, A.B. (Mt. Holyoke College), of Waltham, Mass., has been appointed assistant librarian of the Gray Herbarium of Harvard University to fill a vacancy caused by the resignation of Miss Edith M. Vincent, who, after seventeen years' service at the Gray Herbarium, has accepted a call to a similar position in the botanical library of the Field Museum at Chicago. Miss Lesley C. Brown, A.B. (Vassar College), of Winchester, Mass., has been added to the staff of the herbarium as bibliographer in connection with the continued compilation of the "Card index of new genera, species and varieties of American plants," a quarterly publication begun by Miss Josephine A. Clark and for many years carried on by Miss Mary A. Day, librarian of the herbarium.

Dr. Chas. H. Herty was reelected president of the Synthetic Organic Chemical Manufacturers' Association, at the annual meeting held in New York on December 14.

Professor George Chandler Whipple, of Harvard University, who has for nine years represented the field of sanitary engineering on the Public Health Council of Massachusetts, has resigned from the council.

James A. Foord, professor of farm management at the Massachusetts Agricultural College, has been relieved, at his own request, of the position of head of the division of agriculture at the college, which he has held since 1907. He will give his full time to his chosen field of farm management.

Frederick G. Clapp, geologist of New York City, has sailed from San Francisco and will spend the winter in extensive studies in Australia and New Zealand.

William H. Hoover, of the Astrophysical Observatory of the Smithsonian Institution, sailed for Buenos Aires on January 12 to install apparatus for the measurement of variations in the sun with a view to their use in practical weather forecasting for the Argentine government at La Quiaca, which is 11,000 feet above sea level on the northwest boundary of Argentina.

The second William Thompson Sedgwick Memorial Lecture will be given in Huntington Hall, 491 Boylston Street, Boston, on Friday, January 25, at half past four o'clock, by William Henry Welch, M.D., LL.D., director of the school of hygiene and public health of the Johns Hopkins University, on the "Foundations of public health."

Lieutenant-Colonel H. H. Godman-Austen, known for his work on the geology and geography of India, died on December 2, in his ninetieth year. We have recorded the death of Canon Thomas George Bonney, a leader of geology in England, who died in December, in his ninetieth year. Two other distinguished British geologists celebrated the anniversary of their birth in December. Sir Archibald Geikie attained the age of eighty-eight on December 28, and Sir W. Boyd Dawkins was eighty-five on December 26. Sir Archibald Geikie was elected fellow of the Royal Society in 1865 and Sir Boyd Dawkins in 1867.

Professor Frank Clowes, expert adviser on gas

supply of the Corporation of London, and professor emeritus of chemistry of University College, Nottingham, died on December 15 at his residence in Dulwich, aged seventy-five years.

HERLUF WINGE, of the Zoological Museum of the University of Copenhagen, distinguished for his work in vertebrate paleontology, died on November 10.

UNDER the chairmanship of the Earl of Ronaldshay, president of the Royal Geographical Society, a committee has been formed in London with the object of securing subscriptions to the Shackleton Memorial Fund. It appears the late Sir Ernest Shackleton left a very modest sum to his family. The committee proposes to apply the funds placed at their disposal to two objects: the erection of a suitable memorial to the explorer on the Thames Embankment and to make provision for the support of Mrs. Shackleton, the mother of the explorer, and for the proper education of his children. The many friends of Shackleton in America who may wish to show their concern for the dependents of the explorer, may send their contributions to the Honorable Treasurer of the fund, Mr. Howard Button, 61 Lincoln's Inn Fields, W. C. London.

PROFESSOR LASAREFF, of Moscow, who came to the United States to address the American Zoological Society in Cincinnati on "The Ionic Theory of Nerve Stimulation," sailed for Russia on January 12.

PROFESSOR VON HOYNINGEN-HUENE, head of the geological-paleontological institute of Tubingen University, has gone to Buenos Aires to conduct researches on saurian fossils under the auspices of La Plata University.

DR. T. W. VAUGHAN, of the U. S. Geological Survey, delivered the address of the retiring president of the Washington Academy of Sciences on January 8 on "Oceanography in its relation to other earth sciences."

THE address of the retiring president of the Philosophical Society of Washington was delivered on January 12, by Dr. Walter P. White, on "The ethics of research."

DR. W. M. WHEELER, of the Bussey Institution of Harvard University, was the guest of the zoologists of Indiana University from December 10 to 12. He lectured before the chapter of Sigma Xi on "Bergson's attitude toward instincts," and before the convocation of the whole university on "Ants." These are the first public lectures in entomology to be given at Indiana since the recent estabiishment of courses in entomology in that university.

DR. FRANCIS G. BENEDICT, director of the Carnegie Nutrition Laboratory, gave an illustrated lecture on "The human body as a machine," before the engineers of the General Electric Company, at Lynn, on January 11.

ON December 15, Dr. G. K. Noble, curator of herpetology, American Museum of Natural History, New York, delivered an address at Toronto to the Royal Canadian Institute on the subject "Days and Nights on Santo Domingan Trails." On January 5 Dr. Louis A. Bauer, of the Carnegie Institution, gave an illustrated lecture before the institute entitled "The magnetic earth and the electric atmosphere."

MRS. F. F. PRENTISS has given funds for a new medical library—a memorial to Dr. Dudley P. Allen who died in 1915—which will be erected on a site given by Western Reserve University at Euclid Avenue and Adelbert Road. Dr. Allen was for many years professor of surgery at Western Reserve University School of Medicine, and his library was bequeathed to the Cleveland Medical Library Association.

DR. FRANK BILLINGS has presented to the Institute of Medicine of Chicago the sum of $10,000 to be apportioned in two funds of $5,000 each known as the Lewis L. McArthur and Ludvig Hektoen funds. The income is to be spent in the promotion of investigation in internal medicine, in the payment of honorariums for lectures before the institute, or for such other purposes as the board of governors may direct.

WE learn from *Nature* that Mr. A. Henderson Bishop and his son have given to the University of Glasgow, for the new Zoological Museum, the collection of Coleoptera and Lepidoptera made by the late Thomas G. Bishop, of Dalmore, Helensburg. The collection is contained in 18 cabinets enclosing 700 separate boxes, and numbers some thirty or forty thousand specimens. All are beautifully mounted, labeled, systematically arranged and in perfect condition.

THE late Seymour Coman, of Chicago, left the residue of his estate to the University of Chicago, the income to be used as a Seymour Coman Research Fund for the purpose of bridging the gap between laboratory research in the fundamental sciences as applied to medicine, and clinical investigations. The income will be used for the establishment of three Seymour Coman research fellowships with a stipend of $2,000 to $3,000 per year for each fellow, one in the domain of chemistry applied to medicine, one in preventive medicine, and one in physiology. The incumbents will be required to have the maturity and preparation represented by the Ph.D. or the M.D. degree. The income is expected to grow somewhat in the course of time, and will be used for the establishment of further fellowships of this nature.

THE Gray Herbarium, of Harvard University, has recently received a series of about 430 plants of tropical Africa, chiefly from the interior of Angola. The collection was the gift of Mrs. Richard C. Curtis, of Boston, having been prepared by her while accompanying her husband and his father, Mr. Charles P. Curtis, on a hunting expedition to secure specimens of the giant sable antelope. Many of the plants thus obtained by Mrs. Curtis during the later part of the dry season are believed to be the first of their species to reach any American herbarium. The herbarium has obtained by purchase a considerable series of critical drawings prepared by the late Professor E. Koehne, of Berlin, recording his dissections during the whole course of his monographic studies of the *Lythraceae*. The series exhibits in great detail the morphological characters of nearly all members of this family and brings to America much information regarding the group not previously available on this side of the Atlantic. The herbarium has also recently obtained the personal herbarium of the late archeologist Professor Eduard Seler, of Berlin, including a collection prepared by Professor and Mrs. Seler during their extensive travels in Yucatan, Chiapas and Guatemala, containing much material critically studied by Professor Loesener and other botanists of the Berlin Botanical Museum.

THE Sigma Xi Club, of Carleton College, recently organized with fifteen active members, is devoting the year's program to a review of recent work on "The constitution of matter." The remaining programs of the year comprise: Various Types of Rays, Dr. C. A. Culver, of the Physics Department; The Bohr Theory, Dr. E. A. Fath, of the Astronomy Department; The Quantum Theory, C. C. Furnas, of Shattuck School; Electrical Theory of Valence, Dr. E. O. Ellingson, of St. Olaf College, and Isotopes, Dr. A. T. Lincoln, of the Chemistry Department.

THE California Academy of Sciences announces a course of six Sunday afternoon lectures on Evolution as follows:

January 20. *The laws of heredity,* by DR. L. L. BURLINGAME, associate professor of botany, Stanford University.

January 27. *Heredity and plant breeding,* by DR. E. B. BABCOCK, professor of genetics, University of California.

February 3. *Heredity in man,* by DR. L. L. BURLINGAME, associate professor of botany, Stanford University.

February 10. *The evolution of man,* by DR. HAROLD HEATH, professor of zoology, Stanford University.

February 17. *The present status of Darwinism,* by DR. S. J. HOLMES, professor of zoology, University of California.

February 24. *The trend of the race,* by DR. S. J. HOLMES, professor of zoölogy, University of California.

These lectures are given in the auditorium of the California Academy of Sciences in Golden Gate Park and are free to the public.

Nature says: "We regret to note an announcement in the December issue of *Discovery* that this number is to be the last to appear. All who are interested in the spread of a knowledge and appreciation of the results of scientific investigation among the general public will regret the disappearance of this publication. Since it was founded in 1920, *Discovery* has consistently maintained a high standard of scientific accuracy, and has placed before its readers in clear and non-technical language a large number of articles, necessarily varying considerably in merit, which were selected with the express intention of keeping readers abreast of the latest movements of thought in the scientific world. It was started under favorable auspices at a time when the events of the war had impressed upon the public mind the value of scientific research from a practical point of view. Its committee of management consisted of representatives of the most important of the scientific and learned societies, and amongst its contributors it has numbered some of the most prominent of the scientific men of the day. Yet notwithstanding these facts, and notwithstanding a wide appreciation of its merits as a popular scientific publication, it has failed through lack of support."

UNIVERSITY AND EDUCATIONAL NOTES

A GIFT of $20,000 has been made to Columbia University by an anonymous donor to be used for the exclusive benefit of the Department of Geology, to be known as the James Furman Kemp Fund. The income from the fund may be applied to fellowships, scholarships, loans to students, field research expeditions, office and laboratory researches, purchase of equipment, or other valid requirements for which there are no stated funds regularly advanced by the university.

THE Baker Laboratory of Chemistry was dedicated at Cornell University on December 22. Mr. J. Du-Pratt White, vice-chairman of the Board of Trustees, presided at the exercises; Mr. Baker himself presented the keys of the building to President Farrand who accepted them for the university; Professor L. M. Dennis, head of the Department of Chemistry, spoke briefly on the significance of Mr. Baker's gift to the advancement of both the science and the art of chemistry. The guests then inspected the laboratory and its equipment, and were shown the operation of the mechanical features of the building and of many new forms of apparatus.

THE cornerstone of the new laboratory for the study of psychology at Princeton University was laid

at the university on January 9. Professor Howard C. Warren, of the Department of Psychology; Henry Lane Eno, who gave the money for the building, and President John Grier Hibben were the speakers.

DR. ELMER DREW MERRILL, director of the Bureau of Science of the Philippine Islands and head of the department of botany in the University of the Philippines, has been appointed professor of agriculture and dean of the College of Agriculture in the University of California. Dr. Richard P. Boynton, head of the research laboratories under the Philippine government, has been appointed professor of veterinary science.

DR. JAMES E. KINDRED, formerly assistant professor of biology at Western Reserve University, has been appointed assistant professor of histology and embryology in the Medical School of the University of Virginia at Charlottesville.

DR. ANTON A. DAMPF, director of the Zoological Institute of Königsberg, has received a call from the Agricultural College of Mexico City to take over the post of professor of applied zoology and state entomologist. Dr. Dampf was formerly on the staff of the colonial government of German East Africa.

DISCUSSION AND CORRESPONDENCE

THE NATIONAL SOCIETY FOR THE PRESERVATION OF BUFFALO-GRASS

I HAVE just received an invitation to become a member of the National Society for the Preservation of Buffalo-grass.

Three other somewhat similar invitations lie unanswered upon my table.

On the average I receive three times a week, that is about one hundred and fifty times a year, invitations to join societies, associations, institutes, boards, or committees, which, according to the accompanying prospectuses are about to be called into being, or have been called into being, to promote educational, scientific, philosophic, economic, or social progress, reform, or discussion. I am usually given the alternative of becoming a "charter member" (dues $100) or a member of the "common garden variety" (annual dues $5.00).

I would not be human did I not feel highly complimented at being thus solicited, but I am a student of economics, and I ascertain by computation, that, if I graciously comply with all the invitations I receive, my expenditures will amount in the case of charter or life-memberships, which are solicited, to $15,000 a year, an amount which vastly exceeds my salary; and that, if refraining from the glory of becoming a "charter member," I simply accept ordinary active membership, that will involve an expenditure of $750 a year, really not an inconsiderable amount for a "poor devil."

I am prompted to ask, as I toy with the last accumulation of invitations which burden my desk, whether upon the whole it would not be better, instead of multiplying agencies, to give more support to those which already exist, and whether concerted action might not tend to alleviate the sorrows of those who like myself have a disposition to be useful in their day and generation, but are forced by the *res angusta domi* to refrain from having a part in these commendable movements. Should not amalgamation rather than multiplication be contended for?

Of course there is a great deal to be said against such procedure. It would tend to arrest the seething activities of noble minds. It might reduce the revenues of the United States Post Office, not to speak of the postal revenues of other countries. It would interfere with the ambitions of many hitherto unknown persons to have their names printed as members of boards, committees, societies, etc. To such persons it might be almost heart-breaking to be deprived of the opportunity to shine in a body designed to be "national" or "international" in its scope and purpose. When a citizen of Podunk (a locality made famous by the after-dinner speeches of the Hon. Chauncey M. Depew) has become a member of the "Executive Council" of the "National Society for the Preservation of Buffalo-grass," he becomes to a certain extent an object of veneration in Podunk. It seems cruel to deprive of honor one who has thus attained to exaltation among his fellow-townsmen, by proposing that the National Society for the Preservation of Buffalo-grass should be merged into the National Society of Agrostology, which does not confine itself to Buffalo-grass, but promotes the preservation and propagation of timothy-grass and clover, in fact of all grasses. Furthermore, it is urged, and with great weight, that in these days of specialization, we ought to have men who are willing to concentrate their attention upon Buffalo-grass. Buffalo-grass is disappearing, so we are informed, from vast areas, where at one time it furnished nutriment to millions of buffaloes. It is alleged that Buffalo-grass may shortly become extinct. Of this it is frightful to think. That a grass, which "God made," and which in turn made the buffalo, should die out over hundreds of square miles, which once were covered by it, is cause for poignant regret, and it seems cruel to even suggest a curtailment of the zeal and intelligent efforts of the philagrostic ladies and gentlemen in New York, Washington and Podunk, who are inflamed by a desire to save for the nation the herbage which once carpeted the prairies. I instinctively shrink from such action. Nevertheless, when requested to support the cause, I am constrained, in spite of the inward remonstrances of my loving disposition, to ask whether, after all, the National Society of Agrostology might not do the work which is

proposed to be done by the National Association for the Preservation of Buffalo-grass. Could not the lesser be served by the greater? Might not the part be included in the whole?

I am the more urged to these reflections, when I recall the fact that there are parties who are now thinking of forming a National Society for the Preservation of Mountain Laurel (*Kalmia latifolia*) and the Trailing Arbutus. Poor things! It seems, that unless something is done, the Trailing Arbutus will become extinct at a not far-off date, and the laurel of our hill-sides will all be used up for Christmas decorations. These beautiful plants will go the way of the Passenger Pigeon. Nevertheless there is the awful consideration which confronts me, as I know it does a number of other kind-hearted men, that we are not able out of the slender resources of our salaries to pay the expenses of a president, a secretary, and all the printing, which are involved in carrying on a campaign from year to year, possibly from century to century, for the Preservation of Buffalo-grass or even Trailing Arbutus or Mountain Laurel.

What are we going to do about it? As I look at my desk piled high with requests to contribute to such most worthy causes, I sigh for "the wealth of Ormus and of Ind." Then I turn to my beggarly bank-book, which I have just had balanced, showing that I have available for expenditure the sum of $.23. (Skiddoo!) It is indeed cruelly distressing to think that I can not help to satisfy all the brilliant philagrostic, philozoic, and philanthropic yearnings of an agitated nation. But I have only twenty-three cents in bank!

W. J. Holland

OPALINA JAPONICA SUGIYAMA [NOT METCALF]

In Bulletin 120 of the United States National Museum I described as new *Opalina japonica* from *Rana japonica* from Japan. I have since learned that Takesi Sugiyama had already given this name to an *Opalina* from this same host. Although in both infections which I studied the parasites were a little smaller than in Sugiyama's material, there seems no doubt but his forms and mine are of the same species. The name and both his and my descriptions stand, but the authorship of the name is his. Sugiyama's paper[1] is careful and painstaking and is illustrated by beautiful drawings, many in color, which are well worth study.

Maynard M. Metcalf

The Orchard Laboratory,
Oberlin, Ohio

[1] "Studies on the structure and the nuclear division in a Japanese species of Opalina, *O. japonica*, nov. spec.": in Journ. Coll. Agriculture, Imp. Univ. Tokyo, Vol. VI, no. 4, Nov. 20, 1920.

THE NORTHERN RANGE OF THE SCORPION

In a recent communication to Science (Sept. 28, 1923) Mr. R. L. Webster records the finding of *Vejovis boreus* (Girard) at several localities in the "Bad Lands" district of North Dakota and mentions its occurrence, as indicated by specimens in the National Museum, in Oregon and Idaho in addition to more southern states. As these records do not adequately indicate the northern range of this scorpion, it seems desirable to note that it is not infrequently met with in Montana, northern Idaho and Washington, where I have personally taken specimens close to the Canadian border. Recently Professor C. T. Brues placed in my hands for identification a specimen of this same species which had been taken by Mr. F. S. Carr at Medicine Hat, Alberta, Canada, a place in Lat. 50° N. and noted for its low temperatures.

R. V. Chamberlin

Cambridge, Mass.

I have found scorpions in two localities in Montana. In April, 1922, I found three individuals in a crack in a sandstone escarpment in Township 35 North, Range 1 West, Toole county, Montana. A single individual was found in Section 21, Township 2 South, Range 20 East, one mile west of Columbus, Stillwater county, Montana. It was not convenient to collect the animals and the species was not determined. So far as the writer is aware scorpions have not heretofore been reported from Montana.

Earnest Guy Robinson

Billings, Montana

THE MARQUESAS

Large amounts are annually donated by men of means to various institutions for explorations and research for the advancement of archeology, botany, astronomy, biology and other sciences.

The dying out of the populations in some of the Pacific archipelagoes and the consequent gradual dying out of the seedless breadfruits would seem to call for action of this kind before it is too late. In doing so, not only would some of the most interesting relics of a vanishing people be saved from extinction, but unlike the vast material preserved in museums, they could be made useful for coming generations in furnishing a valuable food.

In "White Shadows in the South Seas," Frederick O'Brien says that the days of the Marquesans are numbered. In an article in the *National Geographic Magazine* for October, 1919, J. W. Church corroborates this and says that his census of that year found only 1,950 people alive in the Marquesas, and that in the five preceding years the population had decreased

more than 33 per cent. and that ten years thence there would not be a full-blooded Marquesan alive. Once populous valleys are already swallowed up by the tropical jungle.

It is a well-known fact that cultivated plants can not successfully compete with the wild vegetation when the protecting arm of man is removed. And as the Marquesan is doomed to extinction, so will his breadfruits—by travelers described as superior to all others of their kind—inevitably follow if man does not intervene. Some of these varieties may have become extinct already or be near extinction. In the Society Islands the situation is but slightly better. I quote as follows from a letter recently received from a correspondent in the Fiji Islands: "The Tongan colonists in these islands seem to be the only people that are giving any attention at all to the breadfruit. I fear that this splendid fruit is gradually being permitted to die out."

While the disappearance of the breadfruits would be an economic loss, there would be, in addition, the sentiment of the loss of that which has been the staff of life of one of the races of man which our own civilization had destroyed. Nor should it be forgotten that while in the sciences and trades a lost art or a lost invention may be rediscovered, in the plant world this is not so, for when the last individual of a species or a variety has passed away, it is irrevocably lost. Again, for all that has been written about the breadfruit and the multiplicity of its forms, the curious fact remains that not more than three varieties appear to have found their way from the South Sea archipelagoes to other lands. Finally, as has already been stated, the gathering together of the breadfruit varieties in the Pacific archipelagoes for a comparative study should add further evidence relative to the much mooted question of the migrations of the peoples within those regions.

Various writers and correspondents have quoted more than 100 variety names of the breadfruit. With a liberal allowance for synonyms there must be at least 35 varieties.

I estimate that an expedition to the Marquesas and Tahiti covering a year would be sufficient to get together the largest number of varieties (including the most valuable ones) at the least expenditure, and that this would cost $8,500. I estimate that it would require three years' work to gather together plants of all the breadfruits in the Pacific, including the Society Islands, Marquesas, Samoa, the Fiji Islands and the Caroline Islands. The expense is estimated at $24,000.

Correspondence relative to the subject is invited.

P. J. WESTER

BUREAU OF AGRICULTURE,
MANILA, P. I.

LABORATORY APPARATUS AND METHODS

DRIED PREPARATIONS OF EARTHWORMS[1]

FOR many years the usual method of studying the structure of the earthworm has been to dissect it wet and to study thin sections of it. This method will doubtless remain the standard. However, I have recently discovered that earthworms, if properly freed from ingested soil, fixed, dehydrated in alcohol and then dried can be readily cut in such a manner as to reveal in a strikingly clear fashion all the structures usually studied, except the histological details. Indeed, these preparations show many details not usually seen in wet dissections or in sections. In brief, the method of preparing the worms is as follows:

Free the worms from their ingested materials without permitting them to eat filter paper or paper towel, since these fibers are difficult to cut when dried. Anesthetize in any approved manner; fix and harden by immersion in, or by injection with, a chromic acid solution (2 to 5 per cent.); lay them out straight in the fixing solution and allow them to harden for 12 to 24 hours; wash for an equal time or longer in running water; dehydrate with alcohol; then permit them to dry at room temperature. Prolonged preservation in alcohol tends to bleach them and the addition of terpeneol (1 part to 19 of 95 per cent. alcohol) has a marked bleaching effect. This is desirable for some types of preparation. In drying, some of the worms shrink somewhat, but many of them, if well hardened, do not shrivel, but the muscular layers become thinner. Dried worms, thus prepared, have a tough, leathery consistency which is firm but not brittle. They can be relaxed in a moist chamber just as insects are relaxed either before or after the dissections are made.

The external features that may be seen as well or better in the dried worm than in the wet are the setae, somewhat abnormally protruding owing to the thinning of the body wall, the nephridial pores, dorsal pores, openings of the receptacula seminis and oviducts. Openings of the vasa deferentia do not show so well as in the wet worms.

To dissect the dried worm hold it in the fingers and cut away portions of the body wall, or split the worm or pieces of it on or near the mid-dorso-ventral plane, using a sharp, thin-bladed scalpel or safety razor blade. The cutting must be done with a clean stroke with a slanting cutting edge. The blade will require frequent honing or stropping. Shaving away successive thin slices usually results in shattering the tissues. A useful preparation, but difficult to make, may be made by slicing away the body wall of the

[1] Contribution from the Zoological Laboratory of the University of Michigan.

sides and dorsum of the anterior 15 to 20 somites. Then the septa or any other parts which obscure the desired structures should be picked away by means of fine-pointed forceps, the points of which have been made sharper by filing or grinding. This work with forceps must always be done under a binocular microscope, and brilliant illumination must be employed. The hearts and certain other parts, if broken in the process of dissection, may be cemented in place by means of white shellac, or euparol.

One of the easiest preparations to make and, at the same time, most useful is made by splitting the anterior 17 to 20 somites in the mid-dorso-ventral plane. Such a preparation reveals all the parts of the digestive system from mouth to intestine. The muscles radiating out from the dorsal wall of the pharynx to the body wall are shown here better than in any wet dissection, or in sections. The openings of the calciferous glands are revealed as large openings a short distance anterior to the crop. Other organs which may be readily identified by any student are the brain, ventral nerve cord, ventral and dorsal blood vessels, parts of nephridia, seminal receptacles and septa. Posterior to the gizzard the mesentery supporting the sub-intestinal bloodvessel may frequently be seen as a plate of thin tissue traversed by branches of the sub-intestinal vessel. In preparations similar to the above the esophagus may be dissected out by means of the fine-pointed forceps. This will lay bare complete nephridia, seminal vesicles, seminal receptacles and many of the finer ramifications of blood vessels. From such preparations the student can gain a better appreciation of the coelom than can otherwise be had. Other useful preparations may be made by cutting parallel to the ventral surface, either above or below the nerve cord which may then be seen with its ganglionic swellings and frequently with unbroken nerves. If the cut is below the nerve cord the subneural blood vessel may be seen applied to the cord with its branches extending along the ventral surface of the nerves.

To show the relationship of setae to the body wall, the muscles which tilt the setae, and the muscle which unites the tip of the ventro-lateral pair of setae with the lateral pair of each half somite cut a strip of the lateral body wall so as to include the two rows of setae and view it from the inner surface. No other kind of preparation that I know of shows these structures so well. Many other dissections have been made, but those described above are sufficient to illustrate the method and to suggest possibilities to the experienced laboratory worker.

The dried preparations have several advantages over wet dissections. Dry surfaces do not reflect the light as do wet surfaces. Outlines appear sharp, there being no fuzziness of the image due to reflections below, or from, the surface of the water. By using a variety of dry preparations, structures can be seen from different points of view than in conventional dissections. This is especially valuable after the student has made his dissection and has studied cross sections. The making of the dried preparations is not difficult, nor especially time consuming, and their preservation is simple. They may be studied with the simple dissecting microscope or with the binocular.

The dissections of dried forms may be mounted on blackened blocks of wood, using glue or shellac as the adhesive, or they may be glued to black paper which has been glued to small blocks of wood. Under no consideration should the preparations be mounted under glass, since reflections from the glass, dust on its surfaces and absorption of light by the glass interfere seriously with good vision. It is better to make new preparations from time to time than to protect them with glass coverings.

Further refinements of this method remain to be worked out and it is hoped to report on them at a later time.

GEORGE R. LA RUE
UNIVERSITY OF MICHIGAN

A SIMPLE SHAKING APPARATUS FOR USE IN ENZYME STUDIES[1]

IN the course of our digestion experiments with castor bean lipase, it was found necessary to devise a shaking apparatus in order to overcome certain conditions that prevented concordant results from being obtained from day to day.

The apparatus used by us, as shown in Figure 1, has given very satisfactory results in our enzyme studies and was constructed as follows:

An old incubator was heated by means of a carbon lamp, the temperature being controlled by means of an electric thermoregulator with condenser. A thermograph was attached to record temperature fluctuations that were found never to exceed $\pm .5°$ C. A grooved wooden wheel ten inches wide and one half inch thick was employed to hold the bottles containing the digestion mix. These bottles were of five cc capacity and were prepared from hard glass ignition tubes of 13 cc capacity. They were held in place by means of copper wire extending through minute perforations in the wheel, the base of the bottles resting in small borings extending partly through the wheel, the dimension of the borings approximating that of the bottles themselves. The wheel was allowed to revolve at 60–70 R. P. M., the power being supplied by a small motor placed outside the incubator and controlled by means of a rheostat. In order to eliminate

[1] Contribution No. 3 from the Department of Agricultural Chemistry, the Pennsylvania State College. The drawing is by Mr. Walter Trainer.

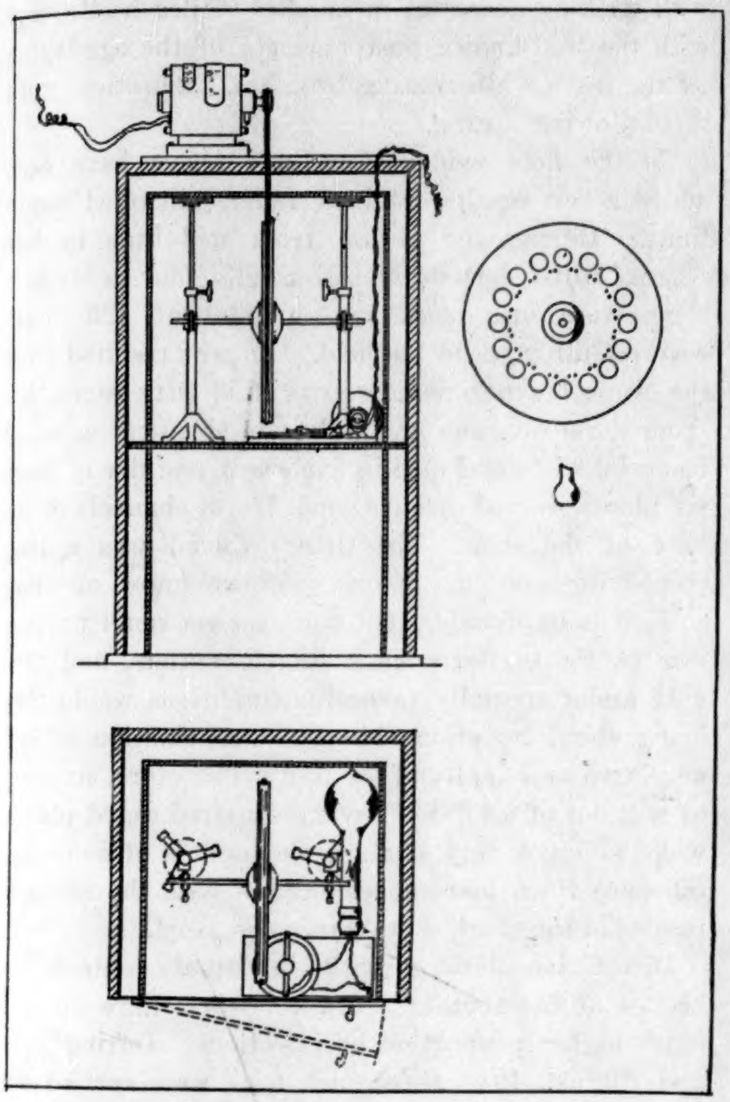

FIG. 1.

the possibility of absorption, the corks of the small bottles were covered with paraffin. This apparatus is to be particularly recommended for studies of this nature, in view of the fact that it can be duplicated readily from materials commonly found in the ordinary chemical laboratory and at a very low cost. If an incubator is not available any similar apparatus properly insulated can be used instead.

D. E. HALEY
H. B. PIERCE

SPECIAL ARTICLES

FURTHER EVIDENCE OF INSECT DISSEMINATION OF BACTERIAL WILT OF CORN

IN two previous papers[1] the writers have discussed some of the results of their experiments and field observations relative to bacterial wilt or Stewart's disease (*Aplanobacter stewarti* EFS emend McCul.) of corn. The cage experiments of 1922 with the brassy flea beetle (*Chaetocnema pulicaria* Melsh.)[2] demonstrated its agency as a carrier in the secondary spread of wilt during mid-season—a hitherto puzzling factor. Similar experiments in 1923 have abundantly confirmed these results and have added the toothed flea beetle (*C. denticulata* Ill.)[2] as a direct disseminator. Briefly, in several field tests aggregating sixteen cloth covered hill-cages, into each of which had been introduced twelve to fifty wilt-fed flea beetles, the final result gave a total of eight healthy plants and forty plants with bacterial wilt. That is, 83 per cent. of the plants in the cage tests contracted the disease.

In 149 control cages into which no insects were experimentally introduced there were 436 healthy plants and five plants with wilt. Of the latter, three cases with abundant yellow ooze characteristic of the disease, and accompanied by small larval channels in the base of the stem, occurred in two hills not caged until the plants were two to three inches tall. A fourth case with yellow ooze and larval channel occurred in a cage together with four healthy plants bearing external evidence of insect injuries at the base of the stem. The last case showed no ooze or bacteria in the stem, but on a leaf blade there were several wilt streaks starting from injuries due to flea beetles. Thus, with exception of five cases of external origin there was no wilt throughout the season in the 441 caged control plants.

The direct dissemination from diseased to healthy plants through the agency of flea beetles easily explains a large part of the mid-season spread of corn wilt, which often makes up the bulk of its seasonal incidence. They leave largely unexplained the sporadic cases of primary infection which appear early in the season without any apparent relation to external dissemination and which seem to originate from within the plant itself, that is, from the stem upward. These cases were at first supposed to come largely from infected seed and possibly also in some instances from infected soil. However, our field and greenhouse experiments during several seasons have clearly pointed away from soil infection as a factor and have apparently brought seed transmission within much narrower limits. From data previously discussed (*loc. cit.*) it may be repeated that under controlled conditions 2 per cent. of wilt is the highest amount obtained from seed collected from badly diseased plants. This evidence, however, does not minimize the importance of seed transmission in introducing wilt into

[1] Rand, Frederick V., and Lillian C. Cash, "Stewart's disease of corn," *Jour. Agric. Research,* 21: 263–264, 1921.

Rand, Frederick V., "Bacterial wilt or Stewart's disease of corn," *The Canner,* 56: 164–166, 1 fig., 1923 (No. 10, Pt. II).

[2] Identified by the Bureau of Entomology.

new sections nor the possibility in some instances of serious direct injury therefrom.

It became increasingly apparent that the facts would be explained if it could be shown that the early seasonal incidence of the disease is due largely to the introduction of the bacterial parasites by insects working at the roots or base of the stem. The following observations and experiments are pertinent to this working hypothesis.

(1) The known geographical distribution of bacterial wilt of maize corresponds closely with the prevalence of the southern corn root worm or 12-spotted cucumber beetle (*Diabrotica duodecempunctata* Oliv.). (2) This insect is reported to be most injurious in wet seasons and on low land. Our experience with wilt has been similar, and, furthermore, during two dry seasons there has been a higher percentage in irrigated than in contiguous unirrigated plots. (3) In a large number of wire-covered cages, which kept out Diabroticas but not flea beetles, there were no early or primary cases. From mid-season onward, however, wilt began to appear from flea beetle injuries on the leaves. (4) Seed of susceptible varieties obtained from wilt-free sections (Maine) has tended to develop an even higher percentage of wilt when planted in five lowland and mountainous sections of Maryland and West Virginia where the disease is prevalent than has seed of the same varieties obtained from and planted in these wilt-prevalent localities. Also under usual field conditions in Maryland and West Virginia seed from Maryland-grown healthy plants is as likely to give a high percentage of wilt as is that collected from badly diseased plants from the same original seed and plot. Furthermore, in both instances just discussed the percentage of *early cases* is as great from "wilt-free" seed as from open market or from "wilt-infected" seed of the same variety. (5) The sporadic appearance and spread of wilt in rows from thoroughly mixed lots of seed and in blocks planted with the same or different seed lots of the same variety suggest insect dissemination in primary as well as secondary cases. (6) Large seed-disinfection tests in the field have averaged as high a percentage of both primary and secondary wilt from treated as from untreated seed of the same lots. (7) In experimental fields in five localities during 1923 a high percentage (62–100 per cent.) of primary stem wilt cases showed small larval channels at the base of the stem. Plants without wilt pulled at random in the thinning out process in these same fields gave a uniformly low percentage (0–17 per cent.) of these larval channels. (8) The amount of wilt has always dwindled nearly or quite to zero in the late summer plantings, even when weather conditions have been apparently as favorable as in case of early plantings developing abundant wilt. This absence of wilt has coincided with striking decreases in number of flea beetles and with the well-known postponement of the egg-laying by the last or hibernating brood of Diabroticas until the following spring.

To the field evidence outlined above have been added a few results obtained under controlled conditions. During the period from mid-June to late August wilt-fed Diabroticas—usually four to six to a cage—were introduced into a total of 129 cloth-covered hill cages in the field. No wilt resulted from the August experiments aggregating fifty cages, but from those of June and July, six clean-cut cases of bacterial wilt developed in five cages, and five of these six plants showed definite small larval channels at the base of the stem. The time involved was a long period of drought. From what we know of other cases it is improbable that more than a small proportion of the beetles would become carriers, and then only under specially favorable conditions would they bring about infection through contamination of egg and larva and finally of the host. Therefore, six cases of wilt out of a total of several hundred caged plants, while giving a very small percentage, is of some significance when taken in connection with the negative results in the check cages above discussed.

Direct inoculations with intestinal contents of beetles of the southern corn rootworm have given a much higher proportion of infections. During June and August, 1923, three such tests were carried out in the field, in cloth cages, in which a total of about 85 plants were inoculated from wilt-fed beetles. Several of these inoculated plants developed within the first week a soft rot at the base and were thrown out of the test. Out of a total of 74 plants left, 15 developed typical wilt with yellow ooze, *i.e.*, 21 per cent. Three similar tests with inoculation at one, two and three days after wilt feeding were carried out in September in the greenhouse with like results, except that a somewhat smaller percentage developed typical signs, due, probably, to the larger proportion of infected plants rejected on account of soft-rot.

During September, 36 adult beetles were collected at random in the vicinity of several of the experimental fields and fed only upon healthy young maize plants for three weeks. Similar inoculations were then made with the intestinal contents of the 26 beetles still alive at the end of this period. At the present writing three typical cases of wilt are noted, although they have not yet been tested by isolation and subsequent reinoculation of the parasite, as was done for a portion of the plants from all the other tests. A similar positive result has just been obtained with beetles fed for five days on wilted plants, then kept for a month out-of-doors on healthy plants before using the intestinal contents for inoculation.

The origin of a large part of the sporadic early

cases of bacterial wilt is, then, still *subjudice* with probabilities strongly in favor of its being due to Diabrotica 12-punctata; as an important means of mid-season spread of the disease flea beetles have been definitely indicated.

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PHYSIOLOGICAL STABILITY IN MAIZE*

THE significant results of Davidson and LeClerc[1] and of Gericke,[2] who obtained increased protein content of wheat grain by delaying the application of nitrates to the soil, raise pertinent questions regarding the possibility of similarly modifying other species and genera of plants. Particular interest attaches to maize in this respect, because of the leading position which it occupies among the crops treated with commercial fertilizers.

Woods[3] has shown that the percentage of protein in maize grain remains constant, despite large increases in yield of crop, with the addition of nitrate of soda to a carrier of potassium and phosphorus. With sand cultures of this plant, Duley and Miller[4] found a decreased percentage of nitrogen in the ears when the concentration of nutrient solution supplied was deficient during the development of this organ, but it should be noted that the supply of nitrogen was not varied independently in this case.

The writer has completed two tests in the greenhouse and one in the field with maize, following the procedure applied to wheat by LeClerc and by Gericke. In the field test the Golden Glow dent variety was grown on Miami silt loam lightly top dressed with farm manure. For the greenhouse test Leaming's Yellow Dent variety was grown on silt loam impoverished by dilution with an equal weight of sand. To this were added liberal supplies of all the essential elements of fertility. In applying the nitrate of soda either one third was added when the plants were about one foot high and the remainder well after the onset of ear filling or the reverse order was followed. In these tests the variations of nitrate supply did not modify the nitrogenous content of the cured seed, excepting in one of the greenhouse tests which was conducted during deficient illumination of the winter months. In this case the application of the greater part of the nitrate at the later stage of growth increased the protein content by 1.5 per cent.

Not only does maize withstand modification of composition through variation of nutrient treatment, but it is also peculiarly free from such modification through variation of climatic factors. The latter characteristic was early observed by Richardson,[5] who found inappreciable differences in the nitrogen content of maize seed reared in widely separated sections of the United States. In their comprehensive treatises on this plant species both Hunt[6] and Burt-Davy[7] quote data showing little influence of climate upon the protein content of the grain. Cooperatively with Professor E. J. Delwiche of the Department of Agronomy at this institution, the writer has found in three out of four years the same protein content of maize grain reared from common seed stock and under closely similar cultural conditions at Ashland and Madison. These Wisconsin stations represent a difference of 250 miles in latitude.

The behavior here emphasized shows marked contrast in comparison with the susceptibility of the sugar beet root and wheat grain to compositional modification through the influence of environmental factors, as shown by Wiley[8] and by LeClerc.[9]

TABLE I

COMPARATIVE NITROGENOUS COMPOSITION OF LEAVES

Date of Sampling	Species of Plant	Dry Matter in Fresh Leaf	Total Nitrogen in Dry Matter	Soluble Nitrogen in Total Nitrogen	Distribution in the Soluble Nitrogen: Protein	Mono Amino	Ammonia	Basic (a)
		%	%	%	%	%	%	%
8/14	maize	27.8	2.0	19	28	29	7	36
8/14	mangold	11.3	5.1	77	80	2	trace	18
8/26	maize	30.6	2.4	21	33	23	3	41
8/26	mangold	13.2	4.4	82	81	5	1	13

(a) Mixed forms, determined by difference.

* Presented in abstract at the annual meeting of the Wisconsin Academy of Sciences, Arts and Letters, Beloit, April 6, 1923. Published with permission of the Director of the Wis. Agric. Expt. Station.

1 Jour. Agric. Res 23: 55, 1923.

2 SCIENCE 52: 446, 1920.

3 Conn. (Storrs) Agric. Expt. Sta. Report, 1889, p. 127.

4 Mo. Agric. Expt. Sta. Res. Bul. 42, 1921.

5 U. S. Dept. Agric., Chem. Div. Bul. 4: 64, 1884.

6 "The Cereals in America," New York, 1910.

7 "Maize, Its History, Cultivation, Handling and Uses," London, 1914.

8 U. D. Dept. Agric., Bur. Chem. Bul. 96, 1905.

9 U. S. Dept. Agric., Bur. Chem. Bul. 128, 1910.

Doubtless differences in genetical constitution should receive consideration in seeking explanation of such difference in behavior, but apparently such consideration must include modifications of the physical and chemical mechanisms within the organism. Possibly the marked deficiency in bulk of tissue interposed between synthetic and storage centers (leaf and root) in the sugar beet as compared with the massive stalk of maize may exercise a controlling influence upon metabolic response, but it is evident that with the former plant species we are dealing with the composition of stem tissue, which may be expected to show greater variability of composition than the seed. In comparing the gross anatomical structure of wheat with that of maize it is noteworthy that, while possessing an even greater proportionate bulk of stem (in terms of dry matter), the former lacks the bulky cob structure of maize.

We are inclined, however, to attach special significance to differences in chemical mechanism within the plant. It would seem profitable, in this connection, to compare the composition of corresponding organs and especially of the leaves, in different plant species, with reference to diurnal and seasonal variations. The data of Table I were obtained by S. Lepkovsky and the writer from chemical analysis of leaf mesophyll tissue from dent maize and sugar mangold, sampled simultaneously from adjacent plantings in the field under identical environmental conditions. While the stage of growth within the complete life cycle of the two plant species was here quite different, the results may serve to suggest the type of differences in metabolic reactions which could be expected to accompany wide differences in physiological stability.

The data of Table I are typical of the relatively low planes of total and soluble nitrogen found in the maize leaf, as compared with that of the sugar mangold. In the former, in addition to a high proportion of insoluble nitrogen, the free amino acids are conspicuous among the less highly organized nitrogenous compounds. These features accompany a relative dryness of tissue in the maize leaf. It is at least noteworthy that plants differing so markedly as these two in physiological behavior should also differ widely in composition of an organ with preponderant synthetic functions. We venture to suggest that results of importance to the explanation of physiological stability in various plant forms may accrue from investigation along the course here outlined. Acknowledgments are due to Professors B. E. Livingston and E. J. Kraus for constructive criticisms incorporated herein.

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THE GEORGIA ACADEMY OF SCIENCE

THE Georgia Academy of Science held its second annual meeting on November 30 and December 1 at the Georgia School of Technology. On Friday afternoon, November 30, there was a short business meeting, at which the officers for next year were elected as follows: W. S. Nelms, Emory University, *president*; B. M. Hall, Atlanta, *vice-president*; Henry Fox, Mercer University, *secretary-treasurer*; J. R. Fain, State College of Agriculture; J. M. Reade, University of Georgia; L. L. Hendren, University of Georgia, and W. V. Skiles, Georgia School of Technology, *members of the eexcutive council*. After the business meeting the rest of the afternoon was given to the presentation of papers, the titles of which were as follows:

The behavior of beta-halogen phosphorus compounds toward alkaline reagents: E. L. JACKSON (introduced by J. S. Guy).

A report on and partial explanation of some long time fertilizer work on fruits: T. H. MCHATTON.

Some general statements concerning the geological development of Georgia: S. W. MCCALLIE.

A transition period in Georgia agriculture: A. M. SOULE (read by title).

Flood control in connection with water power development: B. M. HALL.

At 6.30 p. m. the meeting adjourned for the annual dinner, which was served in the dining-hall of the school of technology, following which the academy School of Technology, following which the academy President M. L. Brittain, of the School of Technology; an address by the retiring president of the academy, Dr. R. P. Stephens, and one by Dr. J. E. Paullin, of Atlanta, on "A bio-chemical consideration of insulin in the treatment of diabetes mellitus."

On Saturday, at 9.00 a. m., the meeting was again called to order and the following papers were presented:

Lightning and some of its effects: D. T. SAVANT (introduced by T. W. Fitzgerald).

Torques and forces between high frequency currents: W. A. PARLIN (introduced by W. S. Nelms).

Potash in Georgia soils: L. M. CARTER (read by title).

Is psychology science? G. C. WHITE.

Modifications in the Morecroft radio sending circuits: J. B. PEEBLES.

Adaptability of pasture plants to the climate and soils of coastal Georgia: J. R. FAIN (read by title).

Studies in the life history of Euglena: W. B. BAKER (introduced by R. C. Rhodes).

HENRY FOX,
Secretary